Space Technology Research Grants

Modeling Cable-Harness Effects on Spacecraft Structures

Completed Technology Project (2011 - 2015)

Project Introduction

The proposed research involves modeling the effects of cable-harnesses and wiring on the dynamics of spacecraft structures. As space structure mass decreases due to the use of lightweight materials, the complex cabling systems used on these structures are becoming a greater percentage of the spacecraft mass, and are changing the dynamic responses of the structures. The goal of this proposal is to develop a scientific basis for describing the effect of power and signal cables attached to lightweight, flexible spacecraft structures in order to determine precise analytical models of such systems to gain understanding of the important physical characteristics that affect their dynamic response. In order to characterize the effects of cable harnesses on spacecraft structures, multiple modeling methods will be developed. The analytical methods proposed include homogenization, the theory of combined dynamical systems, and model updating. Homogenization utilizes the repeating nature of the cable attachment points to simplify the equations used to compare the energy of each section to a fundamental beam model. The theory of combined dynamical systems combines the lumped parameters (attachment points) with the distributed parameters (the structure and cables) and then requires singularity and Green's functions to develop equations. Model updating compares experimental results to existing finite element approximations and adjusts the approximations to more accurately describe the experimentally determined response. In addition to analytical methods, experimental methods will be used to observe and study the effect of cables on structures, and to validate the models developed. An increasingly complex wiring system will be attached to a beam. The dynamic response of the cabled beam will be observed and measured. Specific goals for the first year of research include a method of describing structural cable effects using beam homogenization, culminating in validated homogenization models of cable-harnessed structures; a database of experimental results characterizing the dynamic response of cable-harnessed structures to vibration input; a thorough understanding of experimental requirements and the ability to design and execute a sound and repeatable set of experiments to validate models; and significant progress on methods of describing structural cable effects using the theory of combined dynamical systems and model updating for finite element analysis. This research aligns with Space Technology Area 12.2 (Structures), as well as 11.2 (Modeling). The vibration of space structures is certainly significant in the study of aeronautics and exploration structures, as any structure being propelled into space will experience vibration and is highly likely to have wiring and cables attached. By understanding the vibration modes and effects of these cabled space structures, we will be able to create precise models to predict spacecraft motion and reduce unwanted vibration. In addition, most spacecraft and satellite control systems are dependent on knowing the motion of the object; by further refining our knowledge of spacecraft vibration, we should be able to more accurately model spacecraft and satellite movement, and thus improve the accuracy of space control systems and operations. This research will contribute to the understanding of

Project Image Modeling Cable-Harness Effects on Spacecraft Structures

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

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the dynamics of these systems, and will allow a greater degree of confidence in models for the systems used in exploration systems and space operations. It could be used to make space structures more robust and stable, control systems more accurate, and eventually improve NASA's space and aeronautic technologies.

Anticipated Benefits

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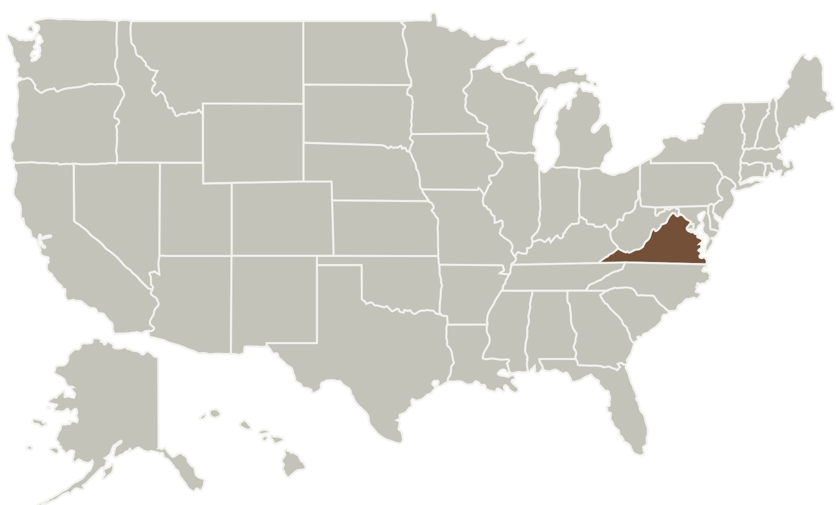
Primary U.S. Work Locations and Key Partners



Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

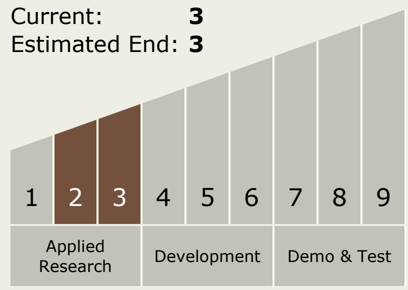
Daniel Inman

Co-Investigator:

Kaitlin S Spak

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.3 Mechanical Systems
    └ TX12.3.1 Deployables, Docking, and Interfaces

Organizations Performing Work	Role	Type	Location
Virginia Polytechnic Institute and State University(VA Tech)	Supporting Organization	Academia	Blacksburg, Virginia

Primary U.S. Work Locations
Virginia

Images

4193-1363192676697.jpg
Project Image Modeling Cable-Harness Effects on Spacecraft Structures
(https://techport.nasa.gov/image/1795)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html